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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/926,188	09/20/2001	Toshihiro Ando	011147	4371

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 02/24/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/926,188	ANDO ET AL.
	Examiner	Art Unit
	Matthew J Song	1765

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09 February 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-4,6,7 and 20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4, 6-7 and 20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

2. Claims 1-4, 6-7 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Imai et al (US 5,001,452) in view of Imai et al (JP 01-103994), an English Abstract and an English Translation have been provided, along with Jin et al (US 5,977,697).

Imai et al ('452) discloses a method of forming a n-type diamond semiconductor (col 1-8) using a reaction gas composed of Ch_4, H_2S and H_2 to form S-doped diamond films on the (100) face of a single crystal diamond substrate by microwave plasma assisted CVD process (Example 1) with a electron mobility of 590 $cm^2/V*s$ (Table 1).

Imai et al ('452) does not disclose mechanically polishing a diamond substrate to make it an inclined diamond substrate.

In a method of growing a diamond single crystal free from defects and having a smooth surface by specifying the orientation of the growth face of the substrate, Imai et al (JP '994) teaches a diamond single crystal layer is grown on a diamond single crystal substrate in a vapor phase, where a polished face having less than a 8° angle to the face orientation of (111) or (100) face is used as the growth face of the substrate and by this method a diamond single crystal layer having satisfactory crystallinity and a flat surface can easily be produced (Abstract).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Imai et al ('452) with Imai et al (JP '994) to grow of crystal of diamond free of defects and having a smooth surface.

The combination of Imai et al ('452) and Imai et al (JP '994) does not disclose subjecting a surface of the inclined diamond substrate to a smoothening treatment making it even.

In a method of forming diamond emitters, note entire reference, Jin et al teaches a diamond thin film is loaded into a microwave plasma chamber for surface treatment, this reads on applicant's smoothening treatment, where the plasma was pure hydrogen and the plasma chamber was operated at a microwave power of 1 kW (1000 W) and a total pressure of 20 Torr, a substrate temperature of 700°C and plasma exposure for 60 minutes. Jin et al also teaches after the treatment process the sample was subjected to a diamond overcoat process in the plasma chamber using methane gas at a substrate temperature of 700°C (col 9, ln 45-67). Jin et al also teaches the hydrogen plasma cleans the diamond surface by removing carbonaceous and oxygen or nitrogen related contaminants and also introduces hydrogen-terminated diamond surface and

the plasma also removed any graphite or amorphous carbon phases present on the surface and along the grain boundaries (col 5, ln 15-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Imai et al ('571) and Imai et al (JP '994) with Jin et al to clean the surface and remove amorphous phases, thereby improving crystallinity.

Referring to claim 1-2, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a similar method of making a n-type semiconductor diamond as applicant. the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al is silent to the crystalline perfectness, the Raman peak, a Kikuchi pattern, carrier concentration and carrier mobility of the n-type diamond and the n-type semiconductor diamond exhibits crystal completeness sufficient to allow operation of said n-type semiconductor diamond as a pn junction device. It is inherent to the n-type diamond taught by the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al to have same because the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a similar method of forming a n-type diamond as applicant.

Referring to claim 3, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a polished inclined diamond substrate with an angle of less than 8° and smoothening the substrate prior to deposition of a n-type diamond by microwave plasma.

Referring to claim 4, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a (100) orientated substrate.

Referring to claim 6, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a pressure of 20 Torr, a microwave output of 1000 W, a temperature of 700°C for a period of 1 hour.

Referring to claim 7, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a temperature of 700°C.

Referring to claim 20, the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al teaches a temperature of 700°C. Temperature is well known in the art to be a result effective variable, note Tsuno et al (US 5,474,021) below. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Imai et al ('571), Imai et al (JP '994) and Jin et al by optimizing the temperature by conducting routine experimentation of a result effective variable (MPEP 2144.05).

Response to Arguments

3. Applicant's arguments filed 2/9/2004 and 12/15/2003 have been fully considered but they are not persuasive.

Applicant's argument that Jin et al does not teach a hydrogen plasma treatment of a substrate is noted but is not found persuasive. Applicants allege that Jin et al teaches a hydrogen plasma treatment of a diamond particle layer and not a substrate. Jin et al teaches applying a hydrogen plasma treatment to a diamond particle layer (col 5, ln 39 to col 6, ln 12), as suggested by applicant. Jin et al also forms a diamond film on the plasma treated diamond particles, therefore the diamond particles are the substrate for the subsequent diamond film and Jin et al does teach a hydrogen plasma treatment of a substrate used for diamond deposition. Furthermore, Jin et al teaches the hydrogen plasma treatment is used to remove carbonaceous and oxygen or nitrogen related contaminants and also introduces hydrogen-terminated diamond surface with low or negative electron affinity and graphite or amorphous carbon phases from a

diamond surface (col 5, ln 60-67). Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Imai et al and Imai with Jin et al's method of removing contaminants from a diamond surface by using a hydrogen plasma to clean the surface, thereby improving crystallinity. Applicants appear to be limiting the teaching of Jin et al to only hydrogen plasma treatment of a diamond particle layer, however Jin et al teaches removing contamination from diamond, which a person of ordinary skill in the art at the time of the invention would found obvious to have apply to other diamond surfaces, such as single crystalline diamond substrates.

Applicant's argument that the prior art does not teach a substrate with steps of one atomic height is noted but is not found persuasive. The combination of Imai et al ('452), Imai et al ('994) and Jin et al teach all of the steps claimed by applicant including an inclined diamond substrate and a microwave plasma treatment using similar pressures, microwave output, temperature and duration, as discussed previously; therefore the effect of the plasma treatment on a similar substrate to make an even substrate surface to consist of steps each in the order of an atomic layer and parameters of claim 1 are inherent to the combination of Imai et al ('452), Imai et al ('994) and Jin et al.

Conclusion

4. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Tsuno et al (US 5,474,021) teaches the temperature and growth plane of a substrate are result effective variable for the growth of diamond single crystal by microwave plasma CVD (Example 1).

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1765

MJS

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER